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MULTI-CRITERIA DECISION ANALYSIS ON THE PREFERENCE OF VIDEO CONFERENCING PLATFORMS USING INTEGRATED AHP-WASPAS MODEL

(Analysis Keputusan Pelbagai Kriteria Terhadap Keutamaan Platform Persidangan Video Menggunakan Model AHP-WASPAS Bersepadu)

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ABSTRACT

The COVID-19 pandemic has changed the way we learn and work. Hybrid or online learning and remote working have become increasingly popular in the academic and professional fields. Video conferencing has emerged to substitute physical working and business travels while making distant learning possible. Video conferencing platforms allow participants to see each other and interact in real time to transfer knowledge, conduct discussions, and make decisions. However, in some cases, technical problems arise because of network latency, programming error, or overloaded server, which impact participants' experience. Assessment on the preference of video conferencing platforms is a multi-criteria decision making (MCDM) problem. This study proposes a MCDM framework with the integrated Analytic Hierarchy Process (AHP) and Weighted Aggregated Sum Product Assessment (WASPAS) model to evaluate the preference of video conferencing platforms among university students in Perak, Malaysia. Based on the AHP-WASPAS model, reliability and stability as well as functionality of the video conferencing platform are the top influential criteria to the university students. According to this study, Microsoft Teams emerged as the most preferred video conferencing platform, followed by Zoom, Google Meet, Skype, and Cisco Webex. The result of this study analyses the capabilities of the video conferencing platforms in relation to the requirements and expectations of university students for online teaching and learning. This study contributes by providing a reference to the universities with online programmes to better evaluate video conferencing platforms for distance learning and webinars. Besides that, video conferencing service providers can also make improvements based on the result of this study.

Keywords: multi-criteria decision making; Analytic Hierarchy Process (AHP); Weighted Aggregated Sum Product Assessment (WASPAS); video conferencing platforms; ranking

ABSTRAK

Pandemik COVID-19 telah mengubah cara kita belajar dan bekerja. Pembelajaran hibrid atau atas talian dan kerja jarak jauh semakin popular dalam bidang akademik dan profesional. Persidangan video telah muncul sebagai pengganti kerja fizikal dan perjalanan perniagaan, di samping membolehkan pembelajaran jarak jauh. Platform persidangan video membenarkan peserta untuk melihat satu sama lain dan berinteraksi secara masa nyata untuk memindahkan pengetahuan, mengadakan perbincangan, dan membuat keputusan. Tetapi, bagi beberapa kes, masalah teknikal timbul disebabkan oleh kependaman rangkaian, ralat pengaturcaraan, atau pelayan yang terlebih beban, yang memberi kesan kepada pengalaman peserta. Penilaian keutamaan platform persidangan video adalah masalah Pembuatan Keputusan Pelbagai Kriteria (MCDM). Kajian ini mencadangkan rangka kerja MCDM dengan model Proses Hierarki Analitik (AHP) dan Penilaian Hasil Agregat Berwajaran (WASPAS) bersepadu untuk menilai keutamaan platform persidangan video di kalangan pelajar universiti di Perak, Malaysia. Berdasarkan model AHP-WASPAS, kebolehpercayaan dan kestabilan serta fungsi platform persidangan video adalah kriteria terpengaruh bagi pelajar universiti. Berdasarkan kajian ini,

Microsoft Teams muncul sebagai platform persidangan video yang paling digemari, diikuti oleh Zoom, Google Meet, Skype, dan Cisco Webex. Hasil kajian ini menganalisis keupayaan platform persidangan video berhubung dengan keperluan dan jangkaan pelajar universiti untuk pengajaran dan pembelajaran atas talian. Kajian ini menyumbang dengan menyediakan rujukan kepada universiti bagi program atas talian untuk menilai platform persidangan video dengan lebih baik bagi pembelajaran jarak jauh dan webinar. Selain itu, penyedia perkhidmatan persidangan video juga boleh membuat penambahbaikan berdasarkan hasil kajian ini.

Kata kunci: pembuatan keputusan pelbagai kriteria; Proses Hierarki Analitik (AHP); Penilaian Hasil Agregat Berwajaran (WASPAS); platform persidangan video; kedudukan

1. Introduction

The COVID-19 pandemic has changed the way we learn and work (Lee *et al*. 2024a). Around the world, schools, colleges, and universities closed their campuses during the pandemic to prevent outbreaks amid lockdowns and social distancing measures (Zheng *et al*. 2021). The Ministry of Higher Education of Malaysia advocated for online teaching and learning in all colleges and universities for the wellbeing of all staff and students (Selvanathan *et al.* 2023). As the pandemic eases, the digitalization of education continues to boom with increase demand for online and distance learning (Ramasamy *et al*. 2023). Remote working has also become popular as interviews, meetings, and seminars take place online to replace physical working and business travels (Müller & Wittmer 2023). This signifies an evolution as technology becomes an enabler for virtual interactions to transfer knowledge, conduct discussions, collaborate, and make decisions in real time (Ferreira *et al*. 2021). The shift towards online teaching and learning is cost-effective for the students as they save on commuting, housing, and facility fees on campus. Students can also record and replay lectures and tutorials for future revisions anytime and anywhere, which enhances flexibility (Dhawan 2020).

Many higher learning institutions in Malaysia are also offering online certifications, diplomas, degrees, and postgraduate studies through open and distance learning (ODL) to be in tune with today's trends (Abdullah & Mohamad Said 2022). To have an effective ODL session, the use of video conferencing platform is inevitable for live sessions where participants engage virtually in real-time (Camilleri & Camilleri 2022). The demand for video conferencing platforms surged dramatically during the pandemic and remains strong in the post-pandemic period, highlighting the importance of video conferencing platforms for a connected world (Suduc & Bizoi 2022). Video conferencing service providers are constantly upgrading their features to meet the demands of users. Basically, users demand for high quality visuals and acoustics for stable and reliable outputs, ease of usage for starting, scheduling, and joining meetings and inviting outsiders and interaction features such as screen sharing and chat functions (Suduc & Bizoi 2022). Some video conferencing platforms offer additional features such as breakout rooms, cancelling background noises, and disables notifications during screen sharing (Karl *et al.* 2022). Even though there are numerous features that drive efficiency in the video conferencing platforms, there are still issues related to systems and architecture which impact participants' experience. High bandwidth is required in video conferencing platforms for undisrupted video transmission (Jimenez *et al.* 2020). However, overloaded servers cause delays in audio and video quality. This high latency and jitter affect the smoothness and clarity of the live sessions and cause user fatigue (Garg *et al.* 2022). Ambiguous instructions to configure video conferencing platforms are also among the problems users face as frequent updates are required for up-to-date features (Anh *et al.* 2023). Meanwhile, data security is also

a legal concern linked to the use of video conferencing platforms (John & Wellmann 2020). All these issues have negative implications to the participants, especially if video conferencing platform is among the main tools for knowledge sharing in universities.

In the past, there have been limited studies on the preference of video conferencing platforms in Malaysia, especially with the use of hybrid multi-criteria decision making (MCDM) model. Toan *et al*. (2022) evaluated video conferencing platforms such as Google Meet, Zoom, Microsoft Teams, and Skype for remote working in Vietnam (Toan *et al*. 2022). Angelova and Stoykova (2023) compared conferencing platforms among students and teachers in Trakia University in Bulgaria (Angelova & Stoykova 2023). Kasirye and Wok (2023) examined the factors influencing video conferencing platforms among students from only a public university in Malaysia (Kasirye & Wok 2023). Ünal and Yilmaz (2024) investigated the acceptance of video conferencing platforms among healthcare professionals (Ünal & Yilmaz 2024). Xu *et al*. (2021) studied the selection of video conferencing platforms in China (Xu *et al*. 2021). Doshi *et al*. (2022) found that Microsoft Teams, Google Meet and Zoom are the top three video conferencing software in NMIMS University in India (Doshi *et al*. 2022). Mastrisiswadi *et al*. (2023) used Analytic Hierarchy Process (AHP) to find the preferences of video conferencing platform with Google Meet, BBB, and Zoom being the most preferred choices (Mastrisiswadi *et al*. 2023). Byun and Choi (2025) studied the preferences of using video conferencing platforms for work and education in Korea (Byun & Choi 2025). Leporini *et al*. (2023) compared the usability of Zoom, Google Meet, and Microsoft Teams among visually impaired users (Leporini *et al*. 2023). A study has been done to compare the performance of Zoom, Microsoft Teams, and Jitsi (Bieringa *et al*. 2021).

Weighted Aggregated Sum Product Assessment (WASPAS) is a combination of Weighted Sum Model (WSM) and Weighted Product Model (WPM) which aims to improve the robustness of the decision making process. Therefore, the aim of this study is to propose a MCDM framework with the integrated Analytic Hierarchy Process (AHP) and WASPAS model to evaluate the preference of video conferencing platforms among the university students in Perak, Malaysia. Based on our best understanding, this paper is the pioneer in proposing AHP-WASPAS model to evaluate the preference of video conferencing platforms. This study is expected to analyze the capabilities of the video conferencing platforms in relation to the requirements and expectations of university students for online teaching and learning. The next section continues with literature review, methodology, result and discussion, and conclusion.

2. Literature Review

The Technology Acceptance Model (TAM) has been popular as a base theory to interpret acceptance (Legramante *et al*. 2023). This model has been adopted to study user behaviour towards a technological product or service (Musa *et al*. 2024). In the development of TAM, Davis (1989) noted that external factors affect perceived ease of use and perceived usefulness, which then determine the attitude and behavioural intention of using a technological product or service (Davis 1989). TAM has been applied in the analysis of e-learning tools (García *et al*. 2024; Granić & Marangunić 2019; Legramante *et al*. 2023; Su & Li 2021), e-wallet and mobile wallet (Kelly & Palaniappan 2023), generative artificial intelligence tools (Ma *et al*. 2025), and healthcare systems (Alsyouf *et al*. 2023; Nazari-Shirkouhi *et al*. 2023; Tetik *et al*. 2024). Therefore, this study uses the TAM as a base theory to analyze the preference of video conferencing platforms.

Ease of use is a criteria that can be used to determine the preference of video conferencing platforms. Luo *et al.* (2023) found that perceived ease of use predicted the preference of video conferencing platforms. Ease of use is a core element of TAM where video conferencing

platforms reduce the cognitive effort while learning, which make them ideal platform for education (Azman *et al.* 2022). When the platform is easy to navigate and reduces cognitive strain, university students are able to participate and learn effectively and efficiently (Bailey *et al.* 2022; Samrgandi 2023). When a technology can be used with minimal effort, a user's attitude towards the technology would be more positive (Taş & Kiraz 2023). When a video conferencing platform is user friendly, the learning efficiency of university students shall be enhanced (Luo *et al.* 2023). Camilleri and Camilleri (2022) also pointed out that the easier it is to use a technology, the greater the usefulness that it can provide (Camilleri & Camilleri 2022). Since the past studies support that ease of use is an influential criterion for the use of video conferencing platform for e-learning, this criteria is adopted in this study (Bailey *et al.* 2022). The second criteria used in this study is security and privacy, which can be largely observed in current literature. A study by Alammary *et al.* (2022) found that the security and privacy of video conferencing platforms to be below acceptable level. Users of these platforms faced a number of security issues such as data leak, malware, phishing, and hijacking (Alammary *et al.* 2022). Kagan *et al.* (2024) also found that images and personal information of video conference meeting participants were publicly available, which jeopardized security and privacy, which is a serious concern especially among students. In a study conducted in the second half of 2022, Zoom and Microsoft Teams received low ratings for security and privacy (Weinberger *et al.* 2023). Inadequate security and privacy compromises the perceived usefulness of the video conferencing platforms as the platforms show weak support for secured usage in educational settings which hinders users away from using the platforms (Chen & Zou 2025; Samrgandi 2023). Therefore, security and privacy can affect the confidence and comfort of users in video conferencing platforms (Sandhu *et al.* 2023; Weinberger *et al.* 2023).

Functionality serves as an important attraction of a video conferencing platform as explained in various studies. Functions such as chat, screen share, raise hand, attendance, recording, and breakout rooms helped in more effective learning as they facilitating more interactions among participants to take place (Almendingen *et al.* 2022). These functions allowed collaboration and discussion for peer support in breakout rooms during online learning in various platforms (Wilkins *et al.* 2023). The organizers or lecturers can provide instructions and feedbacks to students in groups or on a one-to-one basis (Ling *et al.* 2024). Files can also be shared for better learning experience on the video conferencing platforms (Zamiri & Esmaeili 2024). Recording function allowed students to revisit the lecture or tutorial classes for revision to deepen their understandings (Ming *et al.* 2021). Therefore, functionality is an important aspect that can affect the usability of a video conferencing platform, which is in line with perceived usefulness in TAM (Ünal & Yilmaz 2024). It is also important for the video conferencing platforms to be compatible with a wide range of devices and operating systems (Samrgandi 2023). Providing user friendly interfaces on mobile devices, tablets, and computers on different operating systems such as iPad OS, Andriod, iOS, Microsoft Windows, Mac OS, Linux, ensure convenience for all users (Leporini *et al.* 2023; Liu *et al.* 2015). Platform compatibility can allow users to participate in video conferencing meetings anytime and anywhere with any devices (Suduc & Bizoi 2022). Higher compatibility reduces users' effort of accessing the video conferencing platforms. The convenience to access these video conferencing platforms in web browsers and respective applications enhances the effectiveness of learning, which is in line with perceived ease of use in TAM (Al-Samarraie 2019).

Meanwhile, customer support is found to be an important criteria in the past studies. In the study by Toan *et al.* (2022), one of the factors that could affect the intention of using the video conferencing platforms is customer support. When issues such as bug or crash arise, users would get in touch and seek for the assistance of the customer support team to engage with the

technical specialists to resolve the problems (Pal & Vanijja 2020). There should also be sufficient manpower for customer support as video conferencing meetings happen round the clock. Alkhaldi *et al.* (2012) confirmed that customer support could affect user's perceived ease of use while reducing frustruation. Therefore, customer support is being used as a decision criteria in this paper. Given that network latency and jitter happen in video conferencing platforms, reliability and stability is also another criteria to be considered (Jimenez *et al.* 2020). Under heavy workload and scalability, it is important for the video conferencing platform to remain stable and reliable (Bieringa *et al.* 2021). Consistent performance should also be recorded in different devices and locations. For swift disconnection, the video conferencing platform should also be able to recover itself to prevent further interruptions, thus showcasing stability and reliability for critical tasks and increasing perceived usefulness (Freytes & Marques 2005). For a smooth session to take place, audio and video outputs should be stable throughout the entire meeting (Dasari *et al.* 2023). Good audio and video inputs and outputs allow information to be transmitted for knowledge sharing, enhancing perceived usefulness, hence adopted as a decision criteria (Li *et al.* 2024). Therefore, this paper studies the important decision criteria, which include ease of use, security and privacy, functionality, platform compatibility, customer support, reliability and stability, as well as audio and video quality to evaluate the preference of video conferencing platforms among university students in Perak, Malaysia using an integrated AHP-WASPAS model. These decision criteria are essential qualities to affect university students' preference of video conferencing tools, inline with past studies such as Biswas *et al.* (2021) and Toan *et al.* (2022).

AHP is a powerful MCDM model for decision-making and has been used in various fields (Ben Rabia & Bellabdaoui 2023; Lam *et al*. 2020; Lee *et al.* 2024b). WASPAS combines both weighted sum and weighted product models for higher precision (Singh & Modgil 2020). Due to its accuracy, WASPAS has been popular among researchers for decision-making (Solanki *et al.* 2024). AHP is used to compute weight of decision criteria whereas WASPAS is applied to determine the final rank of the decision alternatives (Kannan *et al.* 2022; Koma *et al.* 2025). Hybrid MCDM methods has greater strength in ranking power and reliability (Bhaskar & Khan 2022). AHP-WASPAS has higher consistency and accuracy in ranking alternatives (Dhumras & Bajaj 2024; Seth & Kartheek 2024). This paper is the pioneer study in proposing AHP-WASPAS model to evaluate the preference of video conferencing platforms. AHP is a popular model for pairwise comparisons and has been widely adopted in studies such as transport planning and decision making (Kriswardhana *et al.* 2025; Lin *et al.* 2024; Rivero Gutiérrez *et al.* 2021), location selection (Anderluh *et al.* 2020; Dianawati & Rebecca 2019; Suman *et al.* 2021), and supplier evaluation and selection (Kumendong & Hartono 2022; Lin *et al.* 2023). However, AHP requires pairwise comparisons for the evaluation of decision criteria as well as decision alternatives. The number of pairwise comparison increases with the number of decision criteria and decision alternatives making the process time consuming. Therefore, we propose the integration of AHP and WASPAS model in this study. WASPAS model can be used to determine the priority of decision alternatives without pairwise comparison. WASPAS model has been used in risk assessment (Badalpur & Nurbakhsh 2021; Bid & Siddique 2019; Shabani *et al*. 2025) and evaluation of website (Ou & Chen 2025). AHP-WASPAS has been applied in green supplier selection (Tronnebati *et al.* 2024), sustainable material selection (Aydeniz *et al.* 2025), airline route selection (Koma *et al.* 2025), and public transport service quality evaluation (Tumsekcali *et al.* 2021).

3. Data and Methodology

This paper aims to evaluate the preference of video conferencing platforms among university students in Perak, Malaysia using an integrated AHP-WASPAS model. A study was carried out in Perak, Malaysia with the proposed MCDM framework of AHP-WASPAS model. The steps for AHP-WASPAS is presented as follows (de Assis *et al.* 2023; Li *et al.* 2016):

Step 1: Decomposition of the objective, criteria, and alternatives into a hierarchy structure with three levels. The first level is the objective to evaluate the preference of video conferencing platforms among university students in Malaysia. The second level is the criteria: ease of use, security and privacy, functionality, platform compatibility, customer support, reliability and stability, and audio and video quality. The final level is the alternatives: Zoom, Microsoft Teams, Google Meet, Cisco Webex, and Skype. The proposed hierarchy structure of MCDM framework is presented in Figure 1.

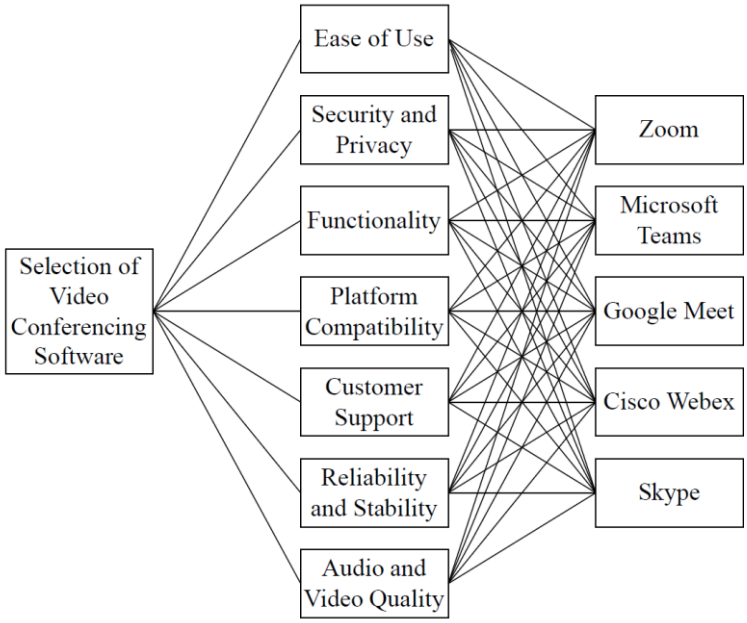

Figure 1: Proposed hierarchy structure of MCDM framework

Step 2: The data of this study consist of the students in Universiti Tunku Abdul Rahman (UTAR), Perak Malaysia. The scale of importance used in the questionnaires is tabulated in Table 1 (Ponsiglione *et al*. 2022).

Table 1: Scale of importance

Scale	Definition
1	Similar strength
3	Slight strength
5	Moderate strength
7	High strength
9	Extremely high strength
2,4,6,8	Intermediaries

Step 3: Based on the data collected, pairwise comparison matrix (A) can be formed. Since there are seven criteria, a 7x7 pairwise comparison matrix for the criteria and seven 5x5 pairwise comparison matrix of the video conferencing platforms with respect to each criterion as shown in Eq. (1) shall be formed.

$$A = \begin{bmatrix} 1 & a_{12} & a_{13} & \cdots & a_{1j} \\ 1/a_{12} & 1 & a_{23} & \cdots & a_{2j} \\ 1/a_{13} & 1/a_{23} & 1 & \cdots & a_{3j} \\ \vdots & \vdots & \cdots & 1 & \vdots \\ 1/a_{1j} & 1/a_{2j} & 1/a_{3j} & \cdots & 1 \end{bmatrix} \quad (1)$$

where a_{ij} is the importance of i compared to j

Step 4: Computation of the weights of criteria. The values in the pairwise comparison matrix shall be divided by the column sum to form the normalized matrix ($\overline{A}_{ij}$) as in Eq. (2). The average of each row of the normalized matrix provides the weight of each criterion (w_i) and the weight of each video conferencing platform with respect to each criterion as shown in Eq. (3).

$$\bar{A}_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (2)$$

$$w_i = \frac{1}{n}\sum_{j=1}^{n} a_{ij} \quad (3)$$

Step 5: Determination of the consistency ratio (CR) as shown in Eq. (4) to Eq. (6). *CR* should be below 0.10 for consistency and significance. The random index (RI) is shown in Table 2.

$$CR = \frac{CI}{RI} \quad (4)$$

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (5)$$

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{(x \times w)_i}{w_i} \quad (6)$$

where CI is the consistency index, RI is the random index and λ_{max} is the largest eigenvalue.

Table 2: *RI* values

n	*RI*
2	0
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.51

Step 6: Formation of matrix for WASPAS according to Eq. (7).

$$X = [x_{ij}]_{m \times n} \tag{7}$$

where
x_{ij} is the preference of ith video conferencing platform with regards to jth criterion
m is the number of video conferencing platforms
n is the number of criteria

Step 7: Creation of normalized matrix ($\bar{x}_{ij}$). To form the normalized matrix, the values in the matrix in Step 5 shall be divided by the column maximum as shown in Eq. (8).

$$\bar{x}_{ij} = \frac{x_{ij}}{max_i x_{ij}} \tag{8}$$

Step 8: Calculation of WSM relative importance ($Q_i^{(1)}$). The WSM relative importance is calculated by obtaining the sum of the product of the normalized matrix in Step 6 and the weight of the criteria obtained in Step 4 as shown in Eq. (9).

$$Q_i^{(1)} = \sum_{j=1}^{n} \bar{x}_{ij} w_j \tag{9}$$

where
w_j is the weight of the criteria j

Step 9: Calculation of WPM relative importance ($Q_i^{(2)}$). The WPM relative importance is the product of the normalized matrix in Step 6 to the power of the weight in Step 4 as shown in Eq. (10).

$$Q_i^{(2)} = \prod_{j=1}^{n} (\bar{x}_{ij})^{w_j} \tag{10}$$

Step 10: Obtain the WASPAS total relative importance (Q_i) according to Eq. (11) as follows. In this study, $\lambda = 0.50$ for a balanced weightage between WSM and WPM to achieve a stable and consistent result (Chen *et al.* 2025; Mishra *et al.* 2019).

$$Q_i = \lambda Q_i^{(1)} + (1 - \lambda) Q_i^{(2)} \tag{11}$$

$$0 \leq \lambda \leq 1 \tag{12}$$

Step 11: Rank the video conferencing platforms. The larger the WASPAS total relative importance, the better the ranking of the video conferencing platform.

In this study, data collection was done using the questionnaires from the students in Universiti Tunku Abdul Rahman (UTAR), Perak Malaysia. UTAR respondents have experiences in using all the video conferencing platforms listed in this study, hence fulfilling the study's criteria. This study includes 100 respondents who are 17 years old and above in foundation, undergraduate, or postgraduate studies. The respondents must have experience in all the five video conferencing platforms, namely Zoom, Microsoft Teams, Google Meet, Cisco Webex, and Skype. Firstly, the questionnaires include the pairwise comparison among the decision criteria as presented in Figure 1. The respondents are then required to determine the importance of decision alternatives in terms of each decision criterion.

4. Results and Discussion

The results of the evaluation of the preference of video conferencing platforms are discussed in this section. Figure 2 demonstrates the weights of the decision criteria according to AHP.

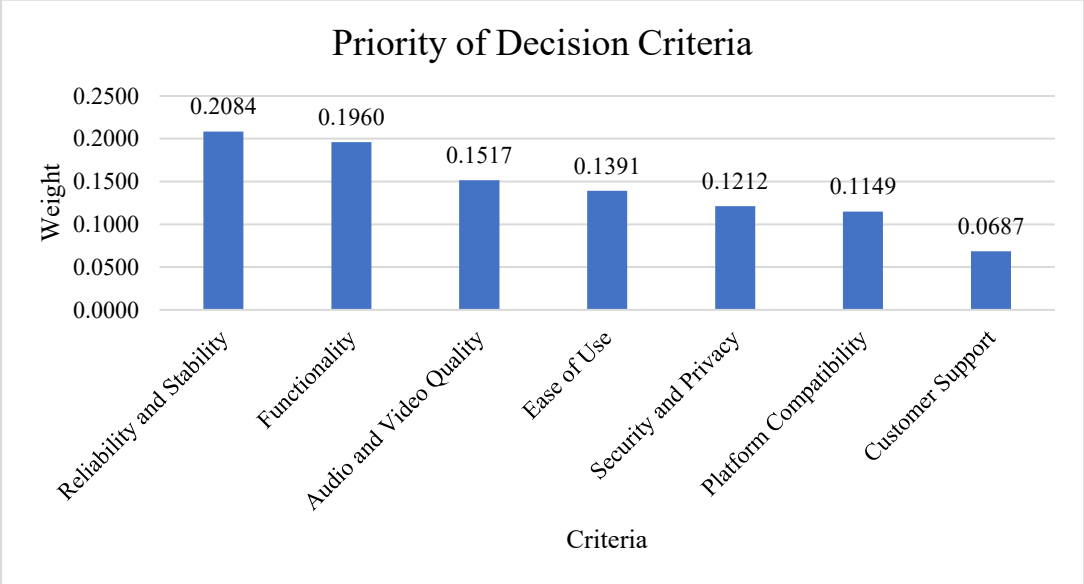

Figure 2: Weights of the criteria

Based on Figure 2, reliability and stability is the most influential criterion for the selection of video conferencing platforms among university students with a weight of 0.2084. University students believe that a smooth and stable network keeps their focus in learning. They are able to listen and see the shared contents clearly for better understanding and to take notes without interruption. Disruption in video conferencing platforms are largely due to latency caused by network congestion and high bandwidth (Jimenez *et al.* 2020). This disruption causes fatigue and demotivates the university students to learn as mentioned by Garg *et al.* (2022). Functionality is the second most influential criterion with a weight of 0.1960. A good video conferencing platform facilitates interactions between the lecturer and university students with chat, screen sharing, file sharing, raise hand, and breakout room functions (Almendingen *et al.* 2022). University students agree that these functions allow them to raise their doubts and learn from their peers through continuous interactions. The third most influential criterion is audio and video quality with a weight of 0.1517. Audio and video clarity allows unambiguous instructions and information to flow within the meeting for higher learning effectiveness (Dasari *et al.* 2023). Ease of use, security and privacy, platform compatibility, and customer support are the fourth to seventh influential criteria respectively. Customer support is the least important criterion because university students would normally contact their respective faculty office or person in charge to resolve any technical issue.

Figure 3 highlights the weights of video conferencing platforms with regards to each criterion. Table 3 shows the rankings of the video conferencing platforms with regards to each criterion. Microsoft Teams has the highest weights with regards to ease of use, customer support, platform compatibility, reliability and stability, functionality, and security and privacy. However, Microsoft Teams should improve on audio and video quality as Microsoft Teams is ranked last in this criterion. Google Meet has the best audio and video quality. However, Google

Meet should work on all the other criteria as Google Meet is ranked third in ease of use, customer support, platform compatibility, reliability and stability, functionality, and security and privacy. Zoom is ranked second in all criteria except audio and video quality, hence improvements are needed in this area. Skype is ranked fourth in six out of seven criteria and ranked third in audio and video quality. Skype is recommended to improve on all the seven criteria to ensure user satisfaction. Cisco Webex has the smallest weights with respect to all the criteria except audio and video quality. Hence, it is vital for Cisco Webex to improve, particularly on ease of use, customer support, platform compatibility, reliability and stability, functionality, and security and privacy. The consistency ratio (*CR*) using a total of 8 matrices in this study is 0.0110, which is well below 0.1000. Hence, the results are consistent and acceptable.

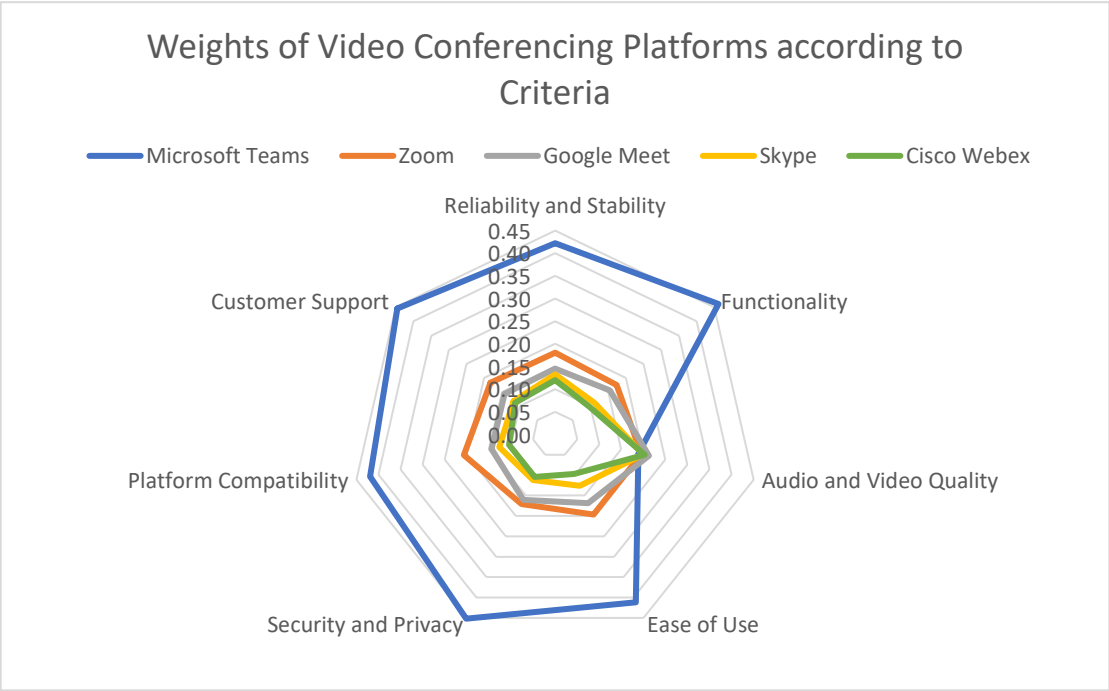

Figure 3: Weights of video conferencing platforms with regards to criteria

Table 3: Rankings of video conferencing platforms with regards to criteria

	Reliability and Stability	Functionality	Audio and Video Quality	Ease of Use	Security and Privacy	Platform Compatibility	Customer Support
Microsoft Teams	1	1	5	1	1	1	1
Zoom	2	2	4	2	2	2	2
Google Meet	3	3	1	3	3	3	3
Skype	4	4	3	4	4	4	4
Cisco Webex	5	5	2	5	5	5	5

Table 4 displays comparison of overall ranking of the video conferencing platforms between the proposed AHP-WASPAS and AHP models.

Table 4: Comparison of the ranking between AHP-WASPAS and AHP models.

Video Conferencing Platform	AHP-WASPAS		AHP	
	Total Relative Importance	Ranking	Total Weight	Ranking
Zoom	0.4875	2	0.1869	2
Microsoft Teams	0.9827	1	0.4015	1
Google Meet	0.4314	3	0.1602	3
Cisco Webex	0.3252	5	0.1185	5
Skype	0.3579	4	0.1328	4

Based on Table 4, the result of AHP-WASPAS model is consistent with the traditional AHP model, which implies that the result of AHP-WASPAS is reliable. AHP-WASPAS contributes by shortening the steps without the need for lengthy pairwise comparison for every alternative in AHP. Microsoft Teams has the highest total relative importance of 0.9827 and is the most preferred video conferencing platform among the university students. Microsoft Teams is the most preferred video conferencing platform because of the ease of scheduling and joining meetings and sharing contents, thus becoming the most popular platform for university students. It is easy to navigate and make use of the functions on Microsoft Teams. When in need of assistance, customer support can be easily located to reduce the anxiety of losing out on learning. However, at times, Microsoft Teams may have high traffic volume which caused latency and jitter that disrupted audio and video quality (Volpe 2024). The preference of video conferencing platforms is followed by Zoom, Google Meet, Skype, and Cisco Webex with 0.4875, 0.4314, 0.3579, and 0.3252 total relative importance respectively based on AHP-WASPAS model. Cisco Webex has the lowest total relative importance likely because it is less user-friendly among university students compared to other video conferencing platforms.

The study of Khalid *et al.* (2023) found that even though meetings are encrypted in Cisco Webex, sensitive information such as credentials, emails, and messages can still be retrieved, which poses high security and privacy concerns among users (Khalid *et al.* 2023). Since reliability and stability is the most important criterion, the video conferencing platforms should continuously enhance and upgrade their edge servers and content delivery networks (CDN) (Taha & Ali 2023). To increase Quality of Service (QoS) and Quality of Experience (QoE), software-defined networking (SDN) can reduce packet loss to ensure high quality video during meetings. However, SDN should also constantly be reviewed and upgraded to ensure consistent performance. This means that the network infrastructure of the video conferencing platforms should be constantly evaluated (Su & Maw 2020). It is also important for all video conferencing platforms to have proper security and privacy features to prevent data leaks, malware, and phishing for increased user confidence.

A sensitivity analysis has been conducted with equal weights of criteria (Tronnebati *et al*. 2024). The results of the sensitivity analysis of AHP-WASPAS model are presented in Table 5. The sensitivity analysis shows that the ranking of video conference platforms using AHP-WASPAS model is consistent with the results of Table 4 above. The integration of WASPAS in the proposed AHP-WASPAS model helps to determine the priority of decision alternatives without pairwise comparison.

Table 5: Sensitivity analysis with equal weight of AHP-WASPAS

Video Conferencing Platforms	Total Relative Importance	Ranking
Zoom	0.4861	2
Microsoft Teams	0.9837	1
Google Meet	0.4256	3
Cisco Webex	0.3200	5
Skype	0.3518	4

5. Conclusion

This study has met its objective to evaluate the video conferencing platforms among university students in Perak, Malaysia using the proposed MCDM framework of AHP-WASPAS model. AHP has been used to identify the weights of decision criteria. Reliability and stability has the highest weightage, which means that university students place the greatest importance on the uninterrupted process of online learning on video conferencing platforms. Functionality has the second most importance, followed by audio and video quality, ease of use, security and privacy, platform compatibility, and customer support. Microsoft Teams appears as the most preferred video conferencing platform, followed by Zoom, Google Meet, Skype, and Cisco Webex. All the video conferencing platforms are recommended to constantly enhance their edge servers, CDN, and SDN to achieve high QoS and QoE for market retention and expansion.

This study has successfully evaluated the capabilities of video conferencing platforms with regards to the requirements and expectations of the university students. This study contributes to academic research as this is the pioneer study that proposes a MCDM framework with integrated AHP-WASPAS model to evaluate the video conferencing platforms among university students. This model can be applied in other areas to evaluate technological products or services. The integration of WASPAS in the proposed AHP-WASPAS model helps to determine the priority of decision alternatives without pairwise comparison. This study also serves as a reference to the universities with online programmes to better evaluate video conferencing platforms for distance learning and webinars. Besides that, video conferencing service providers can also make improvements based on the result of this study, especially in relation to reliability and stability, functionality, audio and video quality, and security and privacy. This study can be conducted in a professional setting to evaluate the preference of video conferencing platforms in the industry.

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